Operating Experience Weekly Summary 97-34

August 15 through August 21, 1997

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EVENTS

1. O-RING FAILURE CAUSES ACID SPILL

On August 15, 1997, at Savannah River Technology Center, an o-ring seal failed during a pressure test on a glass oxidation reaction vessel, shooting a 2-inch plug out of the vessel and spraying approximately 5 liters of acid into the room. The acid sprayed on the floor, walls, computer equipment, and an electrical outlet, causing an electrical arc and smoke and damaging the outlet and computer equipment. The researcher conducting the pressure test noticed the arcing and smoke and left the room to isolate the breaker. However, the breaker and panel were not labeled, and the procedure did not provide any actions in the event of an electrical emergency. He re-entered the room, shut off the damaged computer equipment, and notified his supervisor. Operations personnel responded to the emergency, shut down the electrical circuits, barricaded the laboratory, and initiated containment and neutralization with soda ash. The laboratory facility manager issued a stop work order. Investigators determined that laboratory personnel had modified a cap on the o-ring seal by drilling a hole in it to allow insertion of a plug that was held in place by the o-ring. They also determined that the test procedure did not identify emergency electrical shutdown actions. (ORPS Report SR--WSRC-LTA-1997-0025)

The reaction vessel contained approximately 15 liters of phosphoric acid (85 percent concentration) and 400 ml of nitric acid (70 percent concentration). The vessel design incorporates penetrations that allow researchers to add test materials and insert instruments and equipment. Figure 1-1 shows the original and modified configuration of the o-ring seal. The researcher heated and pressurized the vessel to approximately 8.6 pounds per square inch and 150 degrees Celsius. When he pressurized the vessel, the plug (held by the o-ring) inside a 2-inch connector slid through the o-ring. This caused a rapid pressure release and foaming of the acid, which resulted in the plug and acid shooting into the room.

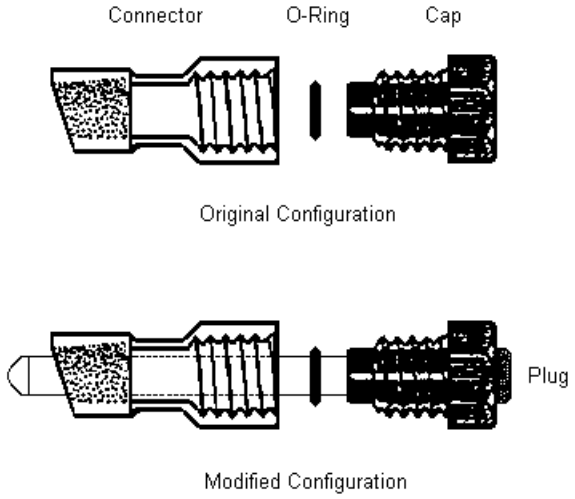

Figure 1-1. Original and Modified Configurations of O-Ring Seal

Operations and research personnel held a critique of the event. They determined that laboratory personnel modified the cap from its original design for an experiment on the digestion of waste products. They also determined that safety management personnel evaluated the design change and discussed its adequacy with the o-ring manufacturer. In addition, safety management personnel inspected the equipment and reviewed the planned experiment before it was set up. Laboratory personnel did not identify any problems during the design change process, so they implemented the new design. Investigators also determined that the safety management inspection did not identify the lack of emergency electrical shutdown plans in the procedure.

Investigators continue to investigate to determine the exact cause of the o-ring seal failure. They initiated a design review and are also investigating to determine whether water in the o-ring could have contributed to the failure. They also determined that the o-rings were not part of a preventive maintenance inspection program. In addition to the investigation and design review, facility managers directed laboratory personnel to implement the following actions.

- Clean-up the acid.
- Prepare and distribute a lessons learned report.
- Repair the electrical outlet.
- Develop instructions for pressure-testing o-rings seals, including guidance for seal maintenance and inspection.
- Develop an emergency electrical shutdown procedure.

Corrective actions will be developed when the investigation is completed. In addition, because this event has been identified as potentially safety significant in accordance with the site reporting procedural requirements, a root cause analysis will be performed.

NFS reported events involving modifications in Weekly Summaries 96-11, 96-10, and 94-09.

- Weekly Summary 96-11 reported that two employees received minor injuries when a work platform in the accelerator tunnel of the Los Alamos Neutron Scattering Center partially collapsed following modifications. An engineering oversight in the design change turned a safety improvement into a personnel hazard. (ORPS Report ALO-LA-LANL-ACCCOMPLEX-1996-0002)
- Weekly Summary 96-10 reported that a radiological control technician and a researcher were exposed to airborne hydrochloric acid fumes at the Los Alamos National Laboratory Radiochemistry Site. The work station was a modified biological hood that included a ventilation system. Investigators found a broken belt on the main fan, which caused a buildup of chemical fumes in the room. The industrial hygienist had not tested the modified biological hood because it was not included in the fume hood database. (ORPS Report ALO-LA-LANL-RADIOCHEM-1996-0004)
- Weekly Summary 94-09 reported the partial flooding of a basement with radioactive water at Brookhaven National Laboratory. Facility personnel had modified piping for a building sump pump normally used to transfer sump contents to a day tank, so they could transfer water from the sump to a 25,000-gallon storage tank. While testing the pump with the modified piping arrangement, the motor failed and radioactive water from the transfer line drained back through the pump into a sump in the basement. A portion of the basement area was flooded with approximately 145 gallons of liquid. (ORPS Report CH-BH-BNL-BNL-1994-0004)

These events underscore the importance of detailed reviews by experts to ensure physical barriers remain intact and operating parameters are not exceeded. Technical reviews should be performed by qualified personnel to ensure that operation and design discrepancies are identified. To the extent practicable, and particularly in the case of innovative design, the design should be independently reviewed by subject matter experts. Design changes that can affect physical barriers must be carefully evaluated. OEAF developed a *Hazard and Barrier Analysis Guide*,

which includes a hazard-barrier matrix showing that physical barriers are among the most effective types of barriers for chemical and pressure sources. The effectiveness of a barrier is related to how suitable or how comprehensive it is in protecting against a particular hazard. The reliability of a barrier is its ability to resist failure. If a physical barrier is modified by untrained personnel, it can lose its effectiveness and reliability. A copy of the *Hazard and Barrier Analysis Guide* is available from Jim Snell, (301) 903-4094, and may also be obtained by contacting the ES&H Information Center, (301) 903-0449, or by writing to ES&H Information Center, U.S. Department of Energy, EH-72/Suite 100, CXXI/3, Germantown, MD 20874.

This event also underscores the importance of analyzing hazards associated with research activities, experiments, and equipment. DOE-HDBK-1100-96, *Chemical Process Hazards Analysis*, provides guidance for identifying hazards associated with hazardous chemicals. The handbook states that hazard analyses must be performed by a team and that team members must have expertise in engineering and process operations. It also states that all hazards, including failure consequences, human factors, and safety effects, must be identified. By performing a thorough review of established administrative controls before unique evolutions, personnel can identify potential weaknesses and evaluate the hazards. DOE-HDBK-1101-96, *Process Safety Management for Highly Hazardous Chemicals*, states: "Process safety management requires an ongoing effort to prevent catastrophic accidents involving hazardous process materials and energies." This handbook's focus is on hazards related to materials and energies present in chemical processes. Also, identifying and analyzing all potential release points for the possibility of an uncontrolled or unmonitored release is essential. Personnel at DOE laboratories should review their procedures to determine if emergency shutdown information is included. Facility management should review policies, procedures, and work packages for inclusion of information before unique or infrequent evolutions are performed.

DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, states: "Procedures should be developed for all anticipated operations, tests, and abnormal or emergency situations." Chapter XVIII, "Equipment and Piping Labeling," requires a well-established and maintained labeling program and states: "a good labeling program… will help reduce operator and maintenance errors resulting form incorrect identification of equipment. Personnel radiation exposure or exposure to hazardous material will also be reduced if operators spend less time identifying components."

National Research Council Publication ISBN 0-309-05229-7, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals,* 1995, provides guidance and recommendations regarding the safe handling and storage of chemicals. The publication states that while the experiments may be prepared and conducted by the laboratory workers, it remains the responsibility of the laboratory supervisor to determine what level of experiment planning is appropriate and to be accountable for necessary training, documentation, and compliance with regulations. Section 5.G, "Working with Highly Reactive or Explosive Chemicals," states that nitric acid is a powerful oxidizing agent with organic compounds. Exothermic reactions can occur when concentrated solutions are heated with substances that are easily oxidized. The section also provides information on chemical incompatibilities. OSHA regulation 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories*, also provides direction on using chemicals and includes information about signs and labels, spills and accidents, basic rules and procedures, and training and information. Information for ordering *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals,* can be obtained from the National Academy Press, 2101 Constitution Avenue, NW, Washington, DC 20418, (202) 334-3313. The book can also be ordered from most book stores.

KEYWORDS: acid, spill, laboratory

FUNCTIONAL AREAS: Chemistry, Modifications

2. POTENTIAL UNREVIEWED SAFTY QUESTION FOR HIGH EFFICIENCY PARTICULATE AIR FILTERS

On August 8, 1997, Kaiser-Hill Company, Nuclear Operations Engineering staff notified the DOE, Rocky Flats Field Office, of a potential unreviewed safety question regarding the structural strength of High Efficiency Particulate Air (HEPA) filters. Kaiser-Hill performed an evaluation of HEPA filter service life to determine the degradation of HEPA filter structural capability because of aging. In addition to filter age, the study evaluated dust-loading and wetting by the fire deluge system. Kaiser-Hill determined that the structural strength of the filter media would not meet their intended function when filter wetting and dust-loading were considered. They also determined that the media is significantly weaker where it folds around aluminum separators. Degraded HEPA filters could create the potential for release of hazardous or radioactive materials to the environment. (ORPS Report RFO--KHLL-SITEWIDE-1997-0001)

During the HEPA filter study, Kaiser-Hill determined that authorization bases require the fire suppression systems to withstand a design basis earthquake that results in a fire. The plenum deluge sprays must protect the HEPA filters during the analyzed fire. The accident scenario assumes failure of the main sprinklers, but relies on the operation of manual plenum deluge sprays to maintain plenum air temperature below 200 degrees Fahrenheit to ensure filter operability. Filter operability is necessary to ensure that off-site doses are maintained below the analyzed results. Kaiser-Hill determined that evaluating filter dust-loading and wetting would approximate the condition that exists during the design basis earthquake scenario. They also determined that filter media strength would be significantly weakened when operators manually activated the deluge sprays because the spray nozzles are directly in front of the HEPA filters. In addition, they determined that the weakest part of the filters would be where the media folds around aluminum separators. When the deluge spray activates and wets the media folds, the filters could collapse. Kaiser-Hill determined that this condition may represent an unreviewed safety question for the following reasons.

- HEPA filter failure could increase the consequences of an accident previously evaluated in the safety analyses.
- Degraded structural strength of the HEPA filters could increase the probability of occurrence of a malfunction of equipment important to safety as previously evaluated in the safety analyses.
- Failure of HEPA filters could create the possibility of a malfunction of equipment important to safety of a different type than previously evaluated in the safety analyses.
- Degraded structural strength could cause failure of HEPA filters at a pressure differential lower than that provided in the operational safety requirements/technical safety requirements operational limits.
- Failure of HEPA filters could result in a significant increase in composite risk for those workers outside the affected facility.

Kaiser-Hill determined that, although this issue may represent an unreviewed safety question, no immediate actions are required. They also determined that facility operations can continue for the following reasons.

- Each facility has multiple stages of HEPA filtration, with only the first stage subjected to periodic, manual deluge spray. The follow-on stages provide defense in depth to maintain filtration capability.

- The accident that challenges the filters requires the fire or heat to spread to the plenum from its place of origin and overcome automatic deluge in the deluge section to raise the filter media temperature above its temperature rating.

Kaiser-Hill intends to form a multi-disciplined task team to develop building-specific strategies for ventilation system operation during fires. They plan to implement these strategies in procedures and training and to change associated authorization bases. In addition, they will determine the best method to test the manual deluge system to ensure that HEPA degradation is minimized. The unreviewed safety question determination is scheduled for completion in September.

NFS reported events involving HEPA filter unreviewed safety questions in Weekly Summaries 94-06, 92-30, and 92-23.

- Weekly Summary 94-06 reported that Rocky Flats Environmental Technology Site personnel identified a safety analysis inadequacy related to the method of testing HEPA filter units. The operational safety requirements for some buildings require only last-stage testing. Testing only the last stage may not provide assurance that a HEPA filter unit will perform as assumed in the final safety analysis report. Test data for HEPA filter stages in two buildings requiring testing at all stages indicates that failures can occur at stages other than the last stage. Therefore, radioactive material release attenuation factors assumed in the final safety analysis report may not be met. As a result, site management personnel declared that testing only the last stage is a potential unreviewed safety question. (ORPS Reports RFO--EGGR-SITEWIDE-1994-0002 and RFO--EGGR-PUFAB-1993-0184)

- Weekly Summary 92-30 reported that the Industrial Hygiene and Safety group at Los Alamos National Laboratory found that some HEPA filters purchased from Flanders Filters, Inc., may not meet certain DOE qualification test requirements. (ORPS Report ALO-LA-LANL-ESHSUPT-1992-0010)

- Weekly Summary 92-23 reported an unreviewed safety question regarding old HEPA filter assemblies at the Hanford B Plant. These filters, highly loaded with radionuclides, might be in a weakened condition and could collapse or perforate if a high differential pressure across the filters were to occur. A loss of water from the water seals could cause a high differential pressure. If the filter failed, contaminated filter debris would have a direct path to the environment. (ORPS RL--WHC-BPLANT-1992-0035)

Configuration management of heating, ventilating, and air handling systems that include HEPA filters should be maintained. Design and operating conditions of such systems should be documented, and installation should be compatible with system and facility design. DOE-STD-1073-93, *Guide for Operational Configuration Management Program*, states: “aging degradation mechanisms most likely to cause failure should be emphasized,” and “walkdowns may be useful for visually identifying unexpected degradation.” Facility managers should consider ensuring that any changes in facility operations or conditions remain bounded by the authorization basis. DOE O 5480.21, *Unreviewed Safety Questions*, establishes program requirements to evaluate the impact of changing conditions that may affect authorization bases. It also ensures that DOE has the approval authority for changes that introduce new hazards and higher-than-approved risks to the public and facility workers. The Order states that the following three criteria are used to identify unreviewed safety questions when changes are made to the facility: (1) if the probability of occurrence or the consequences of an accident that is analyzed in the safety analysis report are

changed; (2) if the possibility of an accident of a different type than analyzed in the report may be created; and (3) if the margin of safety, as defined in any technical specification, is reduced.

The qualification requirements for HEPA filters used in radiological and environmental protection applications are specified in Military Standard MIL-F-51068, *Filter, Particulate, High-Efficiency, Fire-Resistant*, as referenced by DOE O 6430.1A, Ge*neral Design Criteria*, and ASME Standard N509, *Nuclear Power Plant Air-Cleaning Units and Components*. DOE Standard NE F 3-45, *Specifications for HEPA Filters Used by DOE Contractors*, also specifies MIL-F-51068 qualification test requirements. These tests are designed to determine filter performance after being subjected to potential harsh service conditions, including overpressure resistance; resistance to fire and heated air; and resistance to rough handling. Certified proof of testing is also required per ASME N509 and NE F 3-45. The required number of each filter model specified for qualification testing is also contained in MIL-F-51068. Underwriters Laboratory Standard UL-586, *High-Efficiency, Particulate, Air Filter Units*, also discusses requirements for testing HEPA filters.

NFS published Safety Notice DOE/EH-0409, Issue 94-02, “High-Efficiency Particulate Air Filters,” in August 1994. The notice discusses specification, purchase, and application of HEPA filters used in safety-related applications. Safety Notice 94-02 can be obtained by contacting the ES&H Information Center, (301) 903-0449, or by writing to ES&H Information Center, U.S. Department of Energy, EH-72/Suite 100, CXXI/3, Germantown, MD 20874. Safety Notices are also available on the OEAF Home Page at http://tis.eh.doe.gov:80/web/oeaf/lessons_learned/ons/ons.html.

KEYWORDS: unreviewed safety question, HEPA filter

FUNCTIONAL AREAS: Configuration Control, Licensing/Compliance

3. LOSS OF ACCOUNTABILITY OF A SEALED SOURCE

On August 11, 1997, at the Sandia National Laboratory—Albuquerque, a facility manager for the Energy and Environmental Program Division reported loss of accountability of a sealed, 150 mCi tritium source contained in an electron-capture detector and installed in a gas chromatograph. A source custodian did not take responsibility for the source when it was received from the manufacturer, so it was not registered with Sandia's source registrar. In September 1995, Sandia personnel shipped the gas chromatograph to Lockheed-Martin Specialty Components at the Pinellas Plant in Largo, Florida, for field testing. Sandia personnel did not notify personnel at Pinellas that the source required registration, periodic monitoring, and inventorying. Personnel at Pinellas discovered the source while preparing the instrument for return to Sandia in August 1997. They placed the detector and source in a proper Department of Transportation container for shipping. Although the swipe surveys made at that time showed no leakage from this source, leaking sources have resulted in the spread of contamination and personnel exposures. (ORPS Report ALO-KO-SNL-6000-1997-0007)

The facility manager designee determined that, when Sandia personnel received the gas chromatograph from the manufacturer, they were not familiar with the radiological control requirements for sealed sources. Radiological control personnel were upgrading their radiological requirements at the time, which may have contributed to their lack of understanding. The facility

manager designee also determined that the manufacturer did not mention the presence of a radioactive source in their literature, but Sandia personnel did perform a swipe survey of the instrument upon receipt from the manufacturer and again before shipment to the Pinellas Plant. Those swipe surveys did not identify readings above background on a liquid scintillation counter.

The facility manager designee determined that Sandia personnel properly shipped the gas chromatograph in accordance with Department of Transportation requirements. Sandia lessons-learned personnel will issue an occurrence alert at all Sandia National Laboratory locations so that personnel can review the radiological requirements and implement them correctly.

NFS reported radioactive source accountability problems in several Weekly Summaries.

- Weekly Summary 96-13 reported that an employee of a manufacturer of gages containing radioactive sources was internally contaminated from a leaking source. He inhaled americium-241 oxide powder while checking a sealed, 10-mCi americium source for leaks. Bioassay results indicated a committed effective dose equivalent of between 34 and 85 rem. Investigators believe a welded plug that sealed the 1960 vintage source fractured and released the oxide powder. (NRC Event Number 30137)

- Weekly Summary 94-24 reported that personnel at the Hanford Site discovered a cesium-137 source that was not on their sealed radioactive source accountability list. The source was part of a nuclear liquid-level measuring instrument that contained 10 µCi of cesium-137. Health physics technicians established proper control of the source. (ORPS Report RL--WHC-GENERAL-1994-0008)

- Weekly Summary 94-22 reported that radiation control personnel at the Sandia National Laboratory found four radioactive sources that were not entered into the radioactivity source accountability system. A promethium source, measuring 460 mrem/hr beta, was inside a measurement device without a shield in place to prevent exposure. The other three sources were sealed and measured 86 mrem/hr beta. Investigators determined that Sandia personnel lost track of the four sources because they were not entered into the radioactive source accountability system. (ORPS Report ALO-KO-SNL-1000MDL-1994-0002)

- Weekly Summary 93-20 reported that health physics personnel at the Savannah River Site discovered an ion chamber with a sealed 85-µCi source in a dumpster at the Vitrification Facility. They were conducting a search for previously exempted sources that were no longer exempt and required accountability. When health physics personnel searched other areas of the facility, they found three more sources. (ORPS Report SR--WSRC-WVIT-1993-0036)

These events emphasize the importance of strict accountability of radioactive sources and demonstrate the need for a strong radioactive source control program. Personnel responsible for radioactive source control at DOE facilities should ensure their source control program includes the following elements.

- Administrative procedures for the control of accountable sealed radioactive sources.

- Labels on all accountable sources, or their storage containers or devices, with the standard radiation warning trefoil and the words, "Caution, Radioactive Material."

- An individual designated to maintain control of assigned accountable sources. The individual shall be trained as a radiological worker in accordance with 10 CFR 835.902 and instructed on site-specific source control procedures.

- Periodic inventory of each accountable source at intervals not to exceed 6 months. The inventory should verify (1) physical location of each source, (2) adequacy of postings and labels, and (3) adequacy of storage locations, containers, and devices.

- Integrity test of each source (with an activity exceeding 0.005 µCi) upon receipt, when damage is suspected, and at intervals not to exceed 6 months.

The lack of accountability and monitoring of sealed sources can result in lost sources, improperly discarded sources, and failed source integrity that can lead to the spread of contamination and personnel exposure.

DOE/EH-256T, *Radiological Control Manual,* requires control and accountability of sealed radioactive sources. The majority of pertinent radiological protection requirements have become codified through promulgation of 10 CFR 835, *Occupational Radiation Protection*. However, 10 CFR 835 currently does not address sealed radioactive source accountability; source accountability will be addressed in a pending revision. Facility managers should refer to DOE N 441.1, *Radiological Protection for DOE Activities*, for information on the control and accountability of sealed radioactive sources. The administrative lifespan of DOE N 441.1 was from September 30, 1995, to September 30, 1996, but this was extended for 1 year by DOE N 441.2, and will be extended an additional year by DOE N 441.3.

KEYWORDS: sealed source, accountability, radiation protection

FUNCTIONAL AREAS: Radiation Protection

4. WORK INSTRUCTIONS NOT CONSISTENT WITH STANDING ORDER

On August 15, 1997, at the Hanford Site, a shift manager discovered that the instructions in a work package for conducting tank core sampling were not fully consistent with flammable gas ignition controls established in a standing order. The standing order establishes minimum safe distances for vehicular movement near tank inlet breather filters and requires continuous monitoring for flammable gases. Investigators determined that supplemental work instructions in the work package would have allowed flammable gas monitoring as the sole control measure within the area of an inlet breather filter, but the standing order did not allow this option. Further, the package mistakenly identified the breather filter pipe diameter as 4 inches rather than 1 foot. This led to a mistake in determining the control area radius around the breather filter. Placement of the sampling truck inside the control area is not permitted. The truck would sample the tank from a 4-inch riser near the breather filter. The work package preparer's failure to accurately address the standing order requirements, and the pipe diameter could have violated the order and resulted in a potential ignition source near a tank that is known to generate flammable gases. (ORPS Report RL--PHMC-TANKFARM-1997-0068)

On August 14, 1997, nuclear process operators set up a push-mode core sampling truck at a tank in accordance with the work package. A Characterization Project Operations person-in-charge supervised the movement of the truck next to the tank riser to be sampled. He ensured that operators performed continuous monitoring for flammable gases in the area around the inlet

breather filter as specified in the work package. Before moving the truck next to the riser, the person-in-charge measured a 6-foot-diameter control area around the breather filter. On August 15, a shift manager inspected the work area and questioned the position of the truck because the standing order prohibits vehicular movement within 18 pipe diameters or 15 feet (whichever is less) of the inlet breather filter. The rear bumper of the truck was 12 feet from the breather filter opening, which has a diameter of 1 foot. This pipe diameter would have limited the safe distance to 15 feet. The shift manager directed operators to secure the truck and suspended the release of the package pending an investigation.

Investigators determined that the breather filter isolation valve was nearly closed and the truck position did not violate the standing order controls (based on an equivalent pipe diameter of less than 8 inches for the slightly opened valve). Had the breather filter inlet valve been open to an equivalent pipe diameter greater than 8 inches, the position of the core sampling truck would have violated the standing order distance requirement. Investigators also determined that the work package preparer incorrectly stated in the work instructions that ignition source controls did not have to be met as long as personnel performed continuous monitoring for flammable gases. This instruction is inconsistent with the standing order. The order requires meeting ignition source controls and monitoring for flammable gases when work activities could cause a gas release. Investigators believe the work package preparer may have confused the 4-inch tank riser diameter with the filter pipe diameter.

The facility manager initiated a review of similar work packages. The review process will ensure that the work instructions for an affected work package appropriately incorporate the standing order controls before work packages are released for field work.

NFS reported events involving inaccurate work packages in Weekly Summaries 97-30, 97-03, and 97-02.

- Weekly Summary 97-30 reported that a radiological control operations inspector at the Savannah River Site used the wrong source to test the operability of a replacement area monitor. The work package for replacement of the failed monitor did not address the requirement for a specific source to verify operability. (ORPS Report SR--WSRC-FTANK-1997-0011)

- Weekly Summary 97-03 reported that a subcontractor at the Oak Ridge Y-12 Site inserted a fiberglass “fish tape” (a device used for pulling cable) into the wrong conduit where it contacted an energized 13.8-kV electrical switch box. Investigators determined that the work package included incorrect drawings that showed a 4-inch conduit, rather than the 3-inch one the subcontractor was supposed to access. (ORPS Report ORO--USW-ORFICNY12-1997-0001)

- Weekly Summary 97-02 reported that an operator at the Savannah River Site inadvertently backed a front-end loader into a guy wire causing it to break. The cut guy wire contacted and short-circuited a 13.8-kV transformer resulting in a power outage. Investigators determined that a work package did not address safe working distances from wires as specified in a safety manual. (ORPS Report SR--WSRC-SLDHZD-1996-0029)

These events underscore the importance of effective work control programs for work planning and appropriate use of these programs. They also illustrate the importance of communication between work planners and working groups to ensure that activities are specifically identified in work packages and appropriate limits are defined. DOE facility managers should review their work processes to ensure that work packages are accurately prepared and address all orders, directives, and limiting conditions, as well as safety hazards. DOE-STD-1050-93, *Guideline to Good Practices for Planning, Scheduling and Coordination of Maintenance at DOE Nuclear*

Facilities, discusses the need for thorough reviews of work packages by experienced individuals to eliminate errors. Section 3.1.1.3 states that the primary objective of work planning is to identify all technical and administrative requirements for a work activity and to provide the materials, tools, and support activities needed to perform the work. DOE-STD-1034-93, *Guide to Good Practices for Timely Orders to Operators*, states supervisors should review daily and long-term orders during daily briefings to ensure that the information in the order is disseminated to all personnel.

KEYWORDS: work package, work planning, flammable, gas

FUNCTIONAL AREAS: Work Planning